SCHOOL OF BIOTECHNOLOGY

COURSE STRUCTURE FOR INTEGRATED B. Sc. (HONOURS) BIOTECHNOLOGY-M. Sc. BIOTECHNOLOGY PROGRAM

CHOICE BASED CREDIT SYSTEM

B. Sc. (Honours) Biotechnology

SEMESTER I

Course Code	Course Title	L-T-P	Credits
BTL1208	Biochemistry & Metabolism	4-0-4	6
BTL1209	Cell Biology	4-0-4	6
	Professional Communication	2-0-2	3
	Basic Optics/ Differential Calculus	4-0-4/4-2-0	6
BTE1109	Conceptual Organic Chemistry	4-0-4	6
	Total Credits	**18-0-18/ 16-2-14**	**27**

SEMESTER II

Course Code	Course Title	L-T-P	Credits
BTL1105	Mammalian Physiology	4-0-4	6
BTL1106	Plant Anatomy & Physiology	4-0-4	6
	Written Communication	0-0-2	1
	Electromagnetics & EM Waves/ Integral Calculus	4-0-4/4-2-0	6
BTE1201	Coordination Chemistry	4-0-4	6
	Total Credits	**16-0-18/ 16-2-14**	**25**

SEMESTER III

Course Code	Course Title	L-T-P	Credits
BTL2409	Genetics	4-0-4	6
BTL2305	General Microbiology	4-0-4	6
BTE2519/ BTE2520	Molecular Diagnostics/ Industrial Fermentations	4-0-0	4
BTE2301	Thermal & Statistical Physics/ Fundamentals of Algebra/ Fundamentals of Physical Chemistry	4-0-4/ 4-2-0/ 4-0-4	6
XXXXXX	Course from Humanities/Social Science/English-III	3-1-0	4
	Total Credits	**19-1-12/ 19-3-8**	**26**

SEMESTER IV

Course Code	Course Title	L-T-P	Credits
BTL2210	Molecular Biology	4-0-4	6
BTL2521	Basics of Immunology	4-0-4	6
BTE2211/ BTE2705/ BTE2522	Enzymology/ Drug Designing/ Basics of Forensic Science	4-0-0	4
BTE2401	Modern Physics/Probability & Statistics/ Analytical Methods in Chemistry	4-0-4/ 4-2-0/ 4-0-4	6
BTL2805	Studies on Environmental Biology	4-0-0	4
	Total Credits	**20-0-12/ 20-2-8**	**26**

SEMESTER V

Course Code	Course Title	L-T-P	Credits
BTL3523	Bioprocess Technology	4-0-4	6
BTL3524	Recombinant DNA Technology	4-0-4	6
	DSE1	3-0-4	5
	DSE2	3-0-4	5
	Total Credits	**14-0-16**	**22**

SEMESTER VI

Course Code	Course Title	L-T-P	Credits
BTL3611	Bioanalytical Tools	4-0-4	6
BTL3525	Genomics & Proteomics	4-0-4	6
	DSE3	3-0-4	5
	DSE4	3-0-4	5
BTS3107	Seminar		NC
	Total Credits	**14-0-16**	**22**

Total credits: 27 + 25 + 26 + 26 + 22+ 22 = 148

DISCIPLINE SPECIFIC ELECTIVES (Any two per Semester - For Semesters V & VI)

- BTE3609 - Bioinformatics
- BTE3526 - Animal Biotechnology
- BTE3306 - Medical Microbiology
- BTE3108 - Animal Diversity I
- BTE3110 - Plant Diversity I
- BTE3109 - Animal Diversity II
- BTE3111 - Plant Diversity II
- BTE3527 - Plant Biotechnology
- BTE3803 - Environmental Biotechnology
- BTE3112 - IPR, Entrepreneurship, Bioethics & Biosafety
- BTE3307 - Microbial Physiology
- BTE3610 - Introductory Biostatistics
- BTE3804 - Ecology and Environment Management
- BTE3113 - Evolutionary Biology

Subsidiary Courses offered by SoBT for other Integrated Programs

Biotechnology

Semester I	**Biotechnology - I (Basics of Biology) BTE1113**
Semester II	**Biotechnology - II (Molecules & Basic Processes of Life) BTE1114**
Semester III	**Biotechnology - III (Nutrition & Health) BTE2528**
Semester IV	**Biotechnology - IV (Applications of Biology) BTE2529**

Chemistry

Semester I	**Chemistry - I (Conceptual Organic Chemistry) BTE1109**
Semester II	**Chemistry - II (Coordination Chemistry) BTE1201**
Semester III	**Chemistry - III (Fundamentals of Physical Chemistry) BTE2301**
Semester IV	**Chemistry - IV (Analytical Methods in Chemistry) BTE2401**

COMPULSORY COURSE FOR STUDENTS OPTING FOR INTEGRATED PROGRAMS IN MATHS, PHYSICS, BIOTECHNOLOGY, ENGLISH, PHILOSOPHY, ECONOMICS, BBA OFFERED BY SoBT

BTL2805 Semester IV Studies on Environmental Biology (4-0-0 = 4)

Unit-I: MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES & ECOSYSTEMS

Definition, scope and importance, Need for public awareness. Concept of an ecosystem. Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystems: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit-II: NATURAL RESOURCES:RENEWABLE & NON-RENEWABLE RESOURCES

Natural resources and associated problems. Forest resources: Use and over-exploitation, deforestation, case studies; timber extraction, mining, dams and their effects on forest and tribal people. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.

Unit-III: BIODIVERSITY & ITS CONSERVATION FOR SUSTAINABLE DEVELOPMENT

Introduction, Definition, genetic, species and ecosystem diversity; Biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels, India as mega-diversity nation, Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Wildlife Protection Act, Environment Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation. Conservation of biodiversity: *In situ* and *ex situ* conservation of biodiversity.

From Unsustainable to Sustainable development: Urban problems related to energy. Resettlement and rehabilitation of people; its problems and concerns, Case studies. Environmental ethics: Issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, Case studies. Wasteland reclamation. Consumerism and waste products, Public awareness, Water conservation, rain water harvesting, watershed management.

Unit-IV : ENVIRONMENTAL POLLUTION

Definition: Cause, effects and control measures of air pollution, Air (Prevention and Control of Pollution) Act, Water pollution, Water (Prevention and control of Pollution) Act, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards, Solid waste Management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Disaster management: Floods, earthquake, cyclone and landslides.

Unit-V: HUMAN POPULATION & THE ENVIRONMENT

Population growth, variation among nations, Population explosion-Family Welfare Programme. Environment and human health, Human Rights, Value Education, HIV/AIDS, Women and Child Welfare, Role of Information Technology in Environment and human health.

FIELD WORK

- Visit to a local area to document environmental assets-river/forest/grassland/hill/mountain
- Visit to a local polluted site-Urban/Rural/Industrial/Agricultural
- Study of common plants, insects, birds.
- Study of simple ecosystems-pond, river, hill slopes, etc.

Recommended Books:

1. Biodiversity and Conservation, Melchias G, Science, University of Michigan, 2001.
2. Wonders of Indian Wilderness, Bharucha E, Abbeville Press Pub., 2008.
3. Hydrology and Water Resources Engineering, Garg SK, Khanna Publishers.
4. Integrated Solid Waste Management, White PR, *et al*, Lewis Publisher, 1989.
5. Manual on Municipal Solid Waste Management, CPHEEO, Ministry of Urban Development, Govt. of India, New Delhi, 2000.
6. Key concepts of Environmental Chemistry, Hanrahan G, Elsevier Inc., 2012.
7. Principles of Environmental Chemistry, Harrison R, RSC, 2007.
8. Environmental Chemistry, De AK, Wiley Eastern Limited, 2000.
9. Eco-tourism-Principles, Practices and Policies for Sustainability, Wood M, UNEP and TIES.
10. Green Chemistry: Environment Friendly Alternatives. Sanghi R and Srivastava MM, Alpha Science International Ltd., 2003.
11. Social Impact Assessment: An Introduction, Barrow CJ, Oxford University Press, 2000.

SUSIDIARY COURSES IN BIOTECHNOLOGY FOR STUDENTS OPTING FOR INTEGRATED PROGRAMS IN MATHS, PHYSICS

BTE1113 SUBSIDIARY - I Basics of Biology (4-0-4 = 6)

UNIT-I: CHEMICAL BASIS OF LIFE

Chemistry of the living state: micro and macro molecules (including trace elements) associated with structure of the cells and their biological significance. Water: molecular structure, dipolar nature, dissociation of water, concept of pH, Acid and base, buffers.

UNIT-II CELL STRUCTURE & FUNCTION

Cell theory, differences between prokaryote and eukaryote cells, structure and function of the cell membrane. Cellular organelles (ribosomes, mitochondria, chloroplasts, rough ER, smooth ER, Golgi complex, lysosomes, centrioles, vacuoles, cytoskeleton, etc.) and other cellular components (nuclear membrane, cytoplasm, cell wall, and cell membrane).

UNIT-III: CONCEPT OF EVOLUTION & BIOLOGICAL DIVERSITY

How populations evolve, origin of species, tracing evolutionary history, Darwin and theories of evolution, natural selection, evidence for evolution, speciation; evolution of biological diversity; microbial life: prokaryotes and protists, evolution of plant and fungal diversity, evolution of invertebrate diversity, evolution of vertebrate diversity.

UNIT-IV: ECOLOGY & HUMAN WELFARE

Population size and dynamics, biodiversity, competition, predatory/prey interactions, symbiosis, ecosystem ecology - biodiversity, productivity and energy flow, biogeochemistry; molecular ecology, global warming and climate change.

Practicals:

1. Introduction to biology lab and safety practices to be followed in lab
2. Preparation of buffers and reagents
3. Introduction to sterilization techniques like autoclaving
4. Introduction to microscopy and centrifugation technique
5. Microscopic observation of different cell types
6. Isolation of different cellular organelles
7. Isolation of microbes from soil/water/air
8. Study of diverse plant specimens
9. Study of diverse animal specimens
10. Field trips to clear the concept of diversity of life

Recommended Books:

1. Concepts of Biology, Fowler S, Roush R and Wise J, Open Stax Publishers, 2017.
2. Introduction to Biology, 5th Edition, Mackean DG, Hodder Education.
3. Biology, 12th Edition, Raven P, Johnson G, Mason K, Losos J and Singer S, McGraw-Hill Education, 2016.

BTE1113 SUBSIDIARY - II Molecules and Basic Processes of Life (4-0-4 = 6)

UNIT-I: CARBOHYDRATES & LIPIDS

Carbohydrates - introduction to structure and metabolic roles; mono-, di- and polysaccharides, reducing and non-reducing sugars, structure of monosaccharides (glucose and fructose), disaccharides (sucrose, maltose, lactose) and polysaccharides (Cellulose, starch and glycogen). Lipids - introduction to structure and metabolic roles, oils and fats - common fatty acids present in oils and fats, omega fatty acids, trans fats, biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).

UNIT-II: AMINO ACIDS, PROTEINS & NUCLEIC ACIDS

Amino Acids - classification of amino acids, Zwitterion structure and isoelectric point, formation of peptide bond, proteins - metabolic roles of proteins, overview of primary, secondary, tertiary and quaternary structure of proteins;

Components of nucleic acid - adenine, guanine, thymine, uracil and cytosine (only structure), ribose and deoxyribose sugars (only structure); nucleosides and nucleotides (nomenclature only), nucleic acids - structure of DNA (Watson-Crick model) and RNA (types); biological role of DNA and RNA

UNIT-III: LIFE PROCESSES

Cell Cycle - overview of cell cycle, mitosis and meiosis, control of cell cycle in brief; Information dissemination - overview of flow of information, transcription and translation.

UNIT-IV: METABOLIC PROCESSES

Overview of glycolysis, Krebs cycle and electron transport chain, photosynthesis and transpiration, overview of biosynthesis and breakdown of lipids, urea cycle, gluconeogenesis.

Practicals:

1. Differentiate between a reducing/non-reducing sugar
2. Estimation of glucose by DNS or o-toluidine method
3. Carry out saponification of fats
4. Estimation of protein by Lowry or Bradford method
5. Isolation of DNA
6. To carry out agarose gel electrophoresis for DNA
7. Paper chromatography of amino acids
8. Study phases of mitosis from permanent slides
9. Study phases of meiosis from permanent slides

Recommended Books:

1. Fundamentals of Biochemistry: Life at the Molecular Level, Voet D, Voet JG and Pratt CW, Wiley Publications, 2016.
2. Lehninger Principles of Biochemistry, David LN and Michael MC, MacMillan Publications, 2017.
3. Karp's Cell Biology, Karp G, Iwasa J and Marshall W, Wiley Publications, 2018.
4. The Cell: A Molecular Approach, Geoffrey MC, Oxford University Press, 2018.

BTE2528 SUBSIDIARY- III Nutrition and Health (4-0-4 = 6)

UNIT-I: BASIC CONCEPT OF FOOD & NUTRITION

Basic concept of food and nutrition, components of food-nutrients (macro/micronutrients), their biochemical role and dietary sources; food groups and the concept of a balanced diet; causes of food spoilage, food adulteration, nutrition through the life cycle, physiological considerations, nutrient needs and dietary pattern for various groups - adults, pregnant and nursing mothers, infants, pre-school and school children, adolescents and elderly.

UNIT-II: NUTRITIONAL BIOCHEMISTRY

Metabolic roles and sources of carbohydrates, lipids, proteins, essential and non-essential amino acids; enzymes - definition, classification, properties; coenzymes; vitamins - fat soluble and water soluble vitamins; minerals - iron, calcium, phosphorus, iodine, selenium and zinc - their properties.

UNIT-III: HEALTH

Introduction to health - definition and concept of health, major nutritional deficiency diseases, protein energy malnutrition, vitamin deficiency, iron deficiency (anaemia), iodine deficiency disorders, their causes, symptoms, treatment, prevention and government programmes.

Genetic disorders and life style related diseases - hypertension, diabetes mellitus, obesity - their causes and prevention through dietary/lifestyle modifications; social health problems - smoking, alcoholism, drug dependence and acquired immuno deficiency syndrome (AIDS).

UNIT-IV: FOOD HYGIENE & POTABLE WATER

Food hygiene, potable water - sources and methods of purification, food and water borne infections.

Practicals:

1. To detect adulteration in a) ghee b) sugars c) tea leaves d) turmeric
2. To determine absorbed oil content in fried foods
3. Estimation of lactose in milk
4. Ascorbic acid estimation in food
5. Estimation of calcium in foods
6. Preparation of temporary mounts of various stored grain pests
7. Identify nutrient rich sources of foods, their seasonal availability and price
8. Study of nutrition labeling on selected foods

Recommended Books:

1. Fundamentals of Foods, Nutrition and Diet Therapy, 6th Edition, Mudambi SR and Rajagopal MV, New Age International (P) Ltd., 2012.
2. Nutrition Science, 6th Edition, Srilakshmi B, New Age International (P) Ltd., 2018.
3. Food Science, 7th Edition, Srilakshmi B, New Age International (P) Ltd., 2018.
4. Text Book of Human Nutrition, 3rd Edition. Bamji MS, Rao NP and Reddy V, Oxford & IBH Publishing Co. Pvt. Ltd., 2009.
5. Handbook of Nutrition and Food, 3rd Edition, Berdanier CD, Dwyer JT and Heber D, CRC Press, 2013.
6. Wardlaw's Perspectives in Nutrition, 11th Edition, Byrd-Bredbenner C, Moe G, Berning J and Kelley D, McGraw Hill, 2019.

BTE2529 SUBSIDIARY - IV Applications of Biology (4-0-4 = 6)

UNIT-I: INTRODUCTION TO BIOTECHNOLOGY

Introduction, History and Scope of Biotechnology, DNA, RNA, and Protein, Central dogma of Life, Creation of recombinant DNA molecules. Polymerase Chain Reaction (PCR), DNA fingerprinting, Molecular diagnostics, Molecular forensics, Ethical issues in biotechnology, the future of biotechnology.

UNIT-II: PLANTS & THEIR PRODUCTS

Plant and human welfare, Plants as Bio-factories–Concept of bio factories; Production of industrial enzyme, vitamins and antibiotics and other biomolecules; cell culture for secondary metabolite production; production of pharmaceutically important compounds; Bio-energy generation, Genetically Modified crops.

UNIT-III: ANIMALS & THEIR PRODUCTS

Introduction to live stocks and model organism**, V**accines, Cell cloning and micromanipulation, animal and human cloning, Application of genetic engineering: Transgenic animals, Production of recombinant pharmaceuticals, gene therapy, and disease diagnosis, Production of insulin, monoclonal antibodies, enzymes, bio-fuels and bio-therapeutics.

UNIT-IV: MICROBIAL TECHNOLOGY

Bio-degradation, Role of microbes in rhizosphere, Bioremediation and environmental cleanup, Organic manures, bio-fertilizers: soil improvement and amendments; integrated diseases and pest management- use of biocontrol agents, Food Microbiology, Microbes in food industry; food spoilage, poisoning and intoxication. Food Technology: Technological processes for industrial manufacture of selected foods of commercial importance from plant and animal sources.

Practicals:

1. Safety, Check-in, Laboratory record keeping, micropipetting, bacterial culture techniques
2. Bacterial transformation
3. Restriction endonuclease digestion of DNA
4. Agarose gel electrophoresis
5. Polymerase Chain Reaction (PCR)
6. Analysis/Confirmation of PCR product

Recommended Books:

1. Recombinant DNA Technology and Genetic Engineering, Rajagopal K, McGraw Hill Education, 2012.
2. Advanced Biology 2nd International Student Edition: Principles and Applications, Mackean DG, John Murray, 2000.
3. Plant tissue culture: Theory and Practice - Revised Edition, Bhojwani SS and Razdan MK, Elsevier Science Publishers, 2014.
4. Experiments in plant culture-3rd Edition, Dodds JH and Roberts LW, Cambridge University Publishers.
5. Animal Cell and Tissue Culture, Mathur S, Agribios, 2006.

CORE & ELECTIVE COURSES IN BIOTECHNOLOGY

BTL1208 Biochemistry and Metabolism (4-0-4 = 6)

UNIT-I: BIOMOLECULES - I

Amino acids & Proteins**:** Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Level of structural organization of proteins, Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins.

Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions

UNIT-II: BIOMOLECULES - II

Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol.

Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines,. Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA

UNIT-III: ENZYMES & CO-ENZYMES

Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity: types & theories, Biocatalysts from extreme thermophilic and hyperthermophilic archaea and bacteria. Role of: NAD^+, $NADP^{+,}$ FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxal phosphate,lipoic-acid, Biotin vitamin B12, Tetrahydrofolate and metallic ions

UNIT -IV: PRIMARY METABOLISM

Carbohydrates Metabolism: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation. ß-oxidation of fatty acids.

Practicals:

1. To study activity of any enzyme under optimum conditions.
2. To study the effect of pH, temperature on the activity of salivary amylase enzyme.
3. Determination of - pH optima, temperature optima, Km value, Vmax value, Effect of inhibitor (Inorganic phosphate) on the enzyme activity.
4. Estimation of blood glucose by glucose oxidase method.
5. Principles of Colorimetry: (i) Verification of Beer's law, estimation of protein. (ii) To study relation between absorbance and % transmission.
6. Preparation of buffers.
7. Separation of Amino acids by paper chromatography.
8. Qualitative tests for Carbohydrates, lipids and proteins

Recommended Books:

1. Biochemistry, VI Edition, Berg JM, Tymoczko JL and Stryer L, WH Freeman and Co., 2006.
2. Biochemistry and Molecular Biology of Plants, Buchanan B, Gruissem W and Jones R, American Society of Plant Biologists, 2000.
3. Lehninger Principles of Biochemistry, 4th Edition, Nelson DL, Cox MM, WH Freeman and Company, New York, USA, 2004.
4. Introduction to Plant Physiology, Hopkins WG and Huner PA, John Wiley and Sons, 2008.
5. Plant Physiology, Salisbury FB and Ross CW, Wadsworth Publishing Co. Ltd., 1991.

BTL1209 Cell Biology (4-0-4 = 6)

UNIT-I: CELL & CELL PERMEABILITY

Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation.

Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport.

UNIT-II: CELL ORGANELLES-I

Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments.

Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions including role in protein secretion.

UNIT-III: CELL ORGANELLES-II

Lysosomes: Vacuoles and micro bodies: Structure and functions Ribosomes: Structures and function including role in protein synthesis. Mitochondria: Structure and function, Genomes, biogenesis.

Chloroplasts: Structure and function, genomes, biogenesis Nucleus: Structure and function, chromosomes and their structure.

UNIT-IV: CELLULAR MOLECULES & CANCER

Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction.

Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.

Practicals:

1. Study the effect of temperature and organic solvents on semi permeable membrane.
2. Demonstration of dialysis.
3. Study of plasmolysis and de-plasmolysis.
4. Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source.
5. Study of structure of any Prokaryotic and Eukaryotic cell.
6. Microtomy: Fixation, block making, section cutting, double staining of animal tissues like liver, oesophagus, stomach, pancreas, intestine, kidney, ovary, testes.
7. Cell division in onion root tip/ insect gonads.
8. Preparation of Nuclear, Mitochondrial & cytoplasmic fractions.

Recommended Books:

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition.Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASMPress & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

BTL1105 Mammalian Physiology (4-0-4 = 6)

UNIT-I: DIGESTION & RESPIRATION

Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice

Respiration: Exchange of gases, Transport of O_2 and CO_2, Oxygen dissociation curve, Chloride shift.

UNIT-II: CIRCULATION

Composition of blood, Plasma proteins & their role, blood cells, Haemopoisis, Mechanism of coagulation of blood.

Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heart beat.

UNIT-III: MUSCLE PHYSIOLOGY & OSMOREGULATION

Structure of cardiac, smooth & skeletal muscle, threshold stimulus, All or None rule, single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical & electrical events of mechanism of muscle contraction.

Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation.

UNIT-IV: NERVOUS & ENDOCRINE COORDINATION

Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters

Mechanism of action of hormones (insulin and steroids)

Different endocrine glands - Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions.

Practicals:

1. Finding the coagulation time of blood
2. Determination of blood groups
3. Counting of mammalian RBCs
4. Determination of TLC and DLC
5. Demonstration of action of an enzyme
6. Determination of Haemoglobin

Recommended Books:

1. Textbook of Medical Physiology, 9th Edition, Guyton AC and Hall JE, Hercourt Asia PTE Ltd. /WB Saunders Company, 2006.
2. Principles of Anatomy and Physiology, 9th Edition, Tortora GJ and Grabowski S, John Wiley & Sons, Inc., 2006.

BTL1106 Plant Anatomy and Physiology (4-0-4 = 6)

UNIT-I: ANATOMY

The shoot and root apical meristem and its histological organization, simple & complex permanent tissues, primary structure of shoot & root, secondary growth, growth rings, leaf anatomy (dorsi-ventral and isobilateral leaf)

UNIT-II: PLANT WATER RELATIONS, MICRO & MACRO NUTRIENTS

Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanism of opening & closing.

Micro & macro nutrients: criteria for identification of essentiality of nutrients, roles and deficiency systems of nutrients, mechanism of uptake of nutrients, mechanism of food transport.

UNIT-III: CARBON & NITROGEN METABOLISM

Photosynthesis - Photosynthesis pigments, concept of two photo systems, photphosphorylation, calvin cycle, CAM plants, photorespiration, compensation point

Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.

UNIT-IV: GROWTH & DEVELOPMENT

Growth and development: Definitions, phases of growth, growth curve, growth hormones (auxins, gibberlins, cytokinins, abscisic acid, ethylene)

Physiological role and mode of action, seed dormancy and seed germination, concept of photo-periodism and vernalization.

Practicals:

1. Preparation of stained mounts of anatomy of monocot and dicot's root, stem & leaf.
2. Demonstration of plasmolysis by *Tradescantia* leaf peel.
3. Demonstration of opening & closing of stomata
4. Demonstration of guttation on leaf tips of grass and garden nasturtium.
5. Separation of photosynthetic pigments by paper chromatography.
6. Demonstration of aerobic respiration.
7. Preparation of root nodules from a leguminous plant.

Recommended Books:

1. Integrative Plant Anatomy, Dickinson WC, Harcourt Academic Press, USA, 2000.
2. Anatomy of Seed Plants, Esau K, Wiley Publishers, 1977.
3. Plant Anatomy, Fahn A, Pergmon Press, USA, UK, 1974.
4. Introduction to Plant Physiology, Hopkins WG and Huner PA, John Wiley and Sons, 2008.
5. Plant Anatomy, Mauseth JD, The Benjammin/Cummings Publisher, USA, 1988.
6. Lehninger Principles of Biochemistry, 4th Edition, Nelson DL and Cox MM, WH Freeman and Company, New York, USA, 2004.
7. Plant Physiology, Salisbury FB and Ross CW, Wadsworth Publishing Co. Ltd., 1991.
8. Plant Physiology, 4th Edition, Taiz L and Zeiger E, Sinauer Associates Inc. USA, 2006.

BTL2409 Genetics (4-0-4 = 6)

UNIT-I: INTRODUCTION & MENDELIAN GENETICS

Introduction: Historical developments in the field of genetics. Organisms suitable for genetic experimentation and their genetic significance.

Cell Cycle: Mitosis and Meiosis: Control points in cell-cycle progression in yeast. Role of meiosis in life cycles of organisms.

Mendelian genetics : Mendel's experimental design, monohybrid, di-hybrid and tri-hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes, penetrance and expressivity.

UNIT-II: GENOMES

Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes; Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence composition - unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, middle repetitive sequences - VNTRs & dinucleotide repeats, repetitive transposed sequences- SINEs & LINEs, middle repetitive multiple copy genes, noncoding DNA; Genetic organization of prokaryotic and viral genome; Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. packaging of DNA molecule into chromosomes, chromosome banding pattern, karyotype, giant chromosomes, one gene one polypeptide hypothesis, concept of cistron, exons, introns, genetic code, gene function.

UNIT-III: MUTATIONS & SEX DETERMINATION

Chromosome and gene mutations: Definition and types of mutations, causes of mutations, Ames test for mutagenic agents, screening procedures for isolation of mutants and uses of mutants, variations in chromosomes structure - deletion, duplication, inversion and translocation (reciprocal and Robertsonian), position effects of gene expression, chromosomal aberrations in human beings, abonormalities– Aneuploidy and Euploidy.

Sex determination and sex linkage: Mechanisms of sex determination, Environmental factors and sex determination, sex differentiation, Barr bodies, dosage compensation, genetic balance theory, Fragile-X-syndrome and chromosome, sex influenced dominance, sex limited gene expression, sex linked inheritance.

UNIT-IV: MAPPING & INHERITENCE

Genetic linkage, crossing over and chromosome mapping: Linkage and Recombination of genes in a chromosome crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Crossing over at four strand stage, Multiple crossing overs Genetic mapping.

Extra chromosomal inheritance: Rules of extra nuclear inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance, organelle heredity, genomic imprinting.

Evolution and population genetics: In breeding and out breeding, Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, systems of mating, evolutionary genetics, natural selection.

Practicals:

1. Permanent and temporary mount of mitosis.
2. Permanent and temporary mount of meiosis.
3. Mendelian deviations in di-hybrid crosses
4. Demonstration of - Barr Body - *Rhoeo* translocation.
5. Karyotyping with the help of photographs
6. Pedigree charts of some common characters like blood group, color blindness and PTC tasting.
7. Study of polyploidy in onion root tip by colchicine treatment.

Recommended Books:

1. Principles of Genetics, 8th Edition, Gardner EJ, Simmons MJ and Snustad DP, John Wiley & Sons, 2006.
2. Principles of Genetics, 5th Edition, Snustad DP and Simmons MJ, John Wiley and Sons Inc., 2009.
3. Concepts of Genetics, 9th Edition, Klug WS, Cummings MR and Spencer CA, Benjamin Cummings, 2009.
4. Genetics - A Molecular Approach, 3rd Edition, Russell PJ, Benjamin Cummings, 2009.
5. Introduction to Genetic Analysis, 9th Edition, Griffiths AJF, Wessler SR, Lewontin RC and Carroll SB, W H Freeman & Co.

BTL2305 General Microbiology (4-0-4 = 6)

UNIT-I: INTRODUCTION & MICROBIAL DIVERSITY

Fundamentals, History and Evolution of Microbiology; Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria.

Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.

UNIT-II: CULTIVATION & NUTRITION

Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation.

UNIT-III: GROWTH & METABOLISM

Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria.

Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.

UNIT- IV: APPLICATIONS OF MICROBILOGY

Control of Microorganisms: By physical, chemical and chemotherapeutic Agents

Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms; Sewage composition and its disposal.

Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria; Major food born infections and intoxications, Preservation of various types of foods; Fermented foods.

Practicals:

1. Isolation of bacteria & their biochemical characterization.
2. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.
3. Preparation of media & sterilization methods, Methods of Isolation of bacteria from different sources.
4. Determination of bacterial cell size by micrometry.
5. Enumeration of microorganism - total & viable count.

Recommended Books:

1. Modern Food Microbiology, 7th Edition, Jay JM, Loessner MJ and Golden DA, CBS Publishers and Distributors, Delhi, India, 2005.
2. Brock Biology of Microorganisms, 12th Edition, Madigan MT, Martinko JM and Parker J, Pearson/Benjamin Cummings, 2009.
3. Microbiology, 5th Edition, Pelczar MJ, Chan ECS and Krieg NR, McGraw Hill Book Company, 1993.
4. General Microbiology, 5th Edition, Stanier RY, Ingraham JL, Wheelis ML and Painter PR, McMillan, 2005.
5. Microbiology: An Introduction, 9th Edition, Tortora GJ, Funke BR and Case CL, Pearson Education, 2008.
6. Prescott, Harley and Klein's Microbiology, 7th Edition, Willey JM, Sherwood LM and Woolverton CJ, McGraw Hill Higher Education, 2008.

BTL2210 Molecular Biology (4-0-4 = 6)

UNIT-I: DNA STRUCTURE & REPLICATION

DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, DNA polymerases, The replication complex: Pre-primming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

UNI-II: DNA DAMAGE, REPAIR & HOMOLOGOUS RECOMBINATION

DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, translesion synthesis, recombinational repair, nonhomologous end joining. Homologous recombination: models and mechanism.

UNIT-III: TRANSCRIPTION & RNA PROCESSING

RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing, rRNA and tRNA splicing.

UNIT-IV: REGULATION OF GENE EXPRESSION & TRANSLATION

Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation.,Posttranslational modifications of proteins.

Practicals:

1. Preparation of solutions for Molecular Biology experiments.
2. Isolation of chromosomal DNA from bacterial cells.
3. Isolation of Plasmid DNA by alkaline lysis method
4. Agarose gel electrophoresis of genomic DNA & plasmid DNA
5. Preparation of restriction enzyme digests of DNA samples
6. Demonstration of AMES test or reverse mutation for carcinogenicity

Recommended Books:

1. Cell and Molecular Biology: Concepts and Experiments, 6th Edition, Karp G John Wiley & Sons. Inc., 2010.
2. Cell and Molecular Biology, 8th Edition, De Robertis EDP and De Robertis EMF, Lippincott Williams and Wilkins, Philadelphia, 2006.
3. The World of the Cell, 7th Edition, Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP, Pearson Benjamin Cummings Publishing, San Francisco, 2009.
4. Molecular Biology of the Gene, 6th Edition, Watson JD, Baker TA, Bell SP, Gann A, Levine M, and Losick R, Cold Spring Harbour Lab. Press, Pearson Pub., 2008.

BTL2521 Basics of Immunology (4-0-4 = 6)

UNIT-I: INTRODUCTION

Immune Response - An overview, components of mammalian immune system, molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, T- lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors, genome rearrangements during B-lymphocyte differentiation, Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination.

UNIT-II: REGULATION

Regulation of immunoglobulin gene expression - clonal selection theory, allotypes & idiotypes, allelic exclusion, immunologic memory, heavy chain gene transcription, genetic basis of antibody diversity, hypotheses (germ line & somatic mutation), antibody diversity.

UNIT-III: HISTOCOMPATIBILITY COMPLEXES

Major Histocompatibility complexes - class I & class II MHC antigens, antigen processing. Immunity to infection – immunity to different organisms, pathogen defense strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency-AIDS.

UNIT-IV: VACCINES

Vaccines & Vaccination - adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization. Introduction to immunodiagnostics – RIA, ELISA.

Practicals:

1. Differential leucocytes count
2. Total leucocytes count
3. Total RBC count
4. Haemagglutination assay
5. Haemagglutination inhibition assay
6. Separation of serum from blood
7. Double immunodiffusion test using specific antibody and antigen.
8. ELISA.

Recommended Books:

1. Cellular and Molecular Immunology, 6th Edition, Abbas AK, Lichtman AH and Pillai S, Saunders Publication, Philadelphia, 2007.
2. Roitt's Essential Immunology, 11th Edition, Delves P, Martin S, Burton D and Roitt IM, Wiley-Blackwell Scientific Publication, Oxford, 2006.
3. Kuby's Immunolog, 6th Edition, Goldsby RA, Kindt TJ and Osborne BA, WH Freeman and Company, New York, 2007.
4. Janeway's Immunobiology, 7th Edition, Murphy K, Travers P and Walport M, Garland Science Publishers, New York, 2008.
5. Basic and Clinical Immunology, 2nd Edition, Peakman M, and Vergani D, Churchill Livingstone Publishers, Edinberg, 2009.
6. Immunology, 6th Edition, Richard C and Geiffrey S, Wiley Blackwell Publication, 2009.

BTL3523 Bioprocess Technology (4-0-4 = 6)

UNIT-I: INTRODUCTION & CULTURE TYPES

Introduction to bioprocess technology. Range of bioprocess technology and its chronological development. Basic principle components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fedbatch and Continuous culture.

UNIT-II: BIOREACTOR TYPES & DESIGNS

Design of bioprocess vessels - Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application in production processes. Principles of upstream processing - Media preparation, Inocula development and sterilization.

UNIT-III: BIOPROCESS PARAMETRS

Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa. Bioprocess measurement and control system with special reference to computer aided process control.

UNIT-IV: DOWNSTREAM PROCESSING & APPLICATIONS

Introduction to downstream processing, product recovery and purification; Effluent treatment; Microbial production of ethanol, amylase, lactic acid and Single Cell Proteins.

Practicals:

1. Bacterial growth curve.
2. Calculation of thermal death point (TDP) of a microbial sample.
3. Production and analysis of ethanol.
4. Production and analysis of amylase.
5. Production and analysis of lactic acid.
6. Isolation of industrially important microorganism from natural resource.

Recommended Books:

1. Industrial Microbiology, 1st Edition, Casida LE, Wiley Eastern Limited, 1991.
2. Biotechnology: A textbook of Industrial Microbiology, 2nd Edition, Crueger W and Crueger A, Panima Publishing Co., New Delhi, 2000.
3. Industrial Microbiology, 1st Edition, Patel AH, Macmillan India Limited, 1996.
4. Principles of Fermentation Technology, 2nd Edition, Stanbury PF, Whitaker A and Hall SJ, Elsevier Science Ltd., 2006.

BTL3524 Recombinant DNA Technology (4-0-4 = 6)

UNIT-I: TOOLS & APPLICATIONS

Molecular tools and applications- restriction enzymes, ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Microinjection, Electroporation, Ultrasonication, Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR.

UNIT-II: MAPPING & APPLICATIONS

Restriction and modification system, restriction mapping. Southern and Northern hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription,. Genome mapping, DNA fingerprinting, Applications of Genetic Engineering Genetic engineering in animals: Production and applications of transgenic mice, role of ES cells in gene targeting in mice, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each).

UNIT-III: MUTAGENESIS

Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins, Protein engineering concepts and examples (any two).

UNIT-IV: PLANT GENETIC ENGINEERING

Genetic engineering in plants: Use of *Agrobacterium tumefaciens* and *A. rhizogenes*, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors.

Practicals:

1. Isolation of chromosomal DNA from plant cells
2. Isolation of chromosomal DNA from *E. coli*
3. Qualitative and quantitative analysis of DNA using spectrophotometer
4. Plasmid DNA isolation
5. Restriction digestion of DNA
6. Making competent cells
7. Transformation of competent cells.
8. Demonstration of PCR

Recommended Books:

2. Gene Cloning and DNA Analysis, 5th Edition, Brown TA, Blackwell Publishing, Oxford, UK, 2006.
3. Biotechnology-Applying the Genetic Revolution, Clark DP and Pazdernik NJ, Elsevier Academic Press, USA, 2009.
4. Molecular Biotechnology - Principles and Applications of recombinant DNA, Glick BR and Pasternak JJ, ASM Press, Washington, 2003.
5. Principles of Gene Manipulation and Genomics, 7th Edition, Primrose SB and Twyman RM, Blackwell Publishing, Oxford, UK, 2006.
6. Molecular Cloning-A Laboratory Manual, 3rd Edition, Sambrook J, Fritsch EF and Maniatis T, Cold Spring Harbor Laboratory Press, 2001.

BTL3611 Bioanalytical Tools (4-0-4 = 6)

Unit-I: MICROSCOPY & SPECTROSCOPY
Simple microscopy, phase contrast microscopy, florescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy.

Unit-II: TECHNIQUES
Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infra- red), centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.

UNIT-III: CHROMATOGRAPHY
Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.

UNIT-IV: ELECTROPHORESIS
Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno- electrophoresis, isoelectric focusing, Western blotting. Introduction to Biosensors and Nanotechnology and their applications.

Practicals:
1. Native gel electrophoresis of proteins
2. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.
3. Preparation of the sub-cellular fractions of rat liver cells.
4. Preparation of protoplasts from leaves.
5. Separation of amino acids by paper chromatography.
6. To identify lipids in a given sample by TLC.
7. To verify the validity of Beer's law and determine the molar extinction coefficient of NADH.

Recommended Books:

1. Cell and Molecular Biology: Concepts and Experiments, 6th Edition, Karp G, John Wiley& Sons. Inc., 2010.
2. Cell and Molecular Biology, 8th Edition, De Robertis EDP and De Robertis EMF, Lippincott Williams and Wilkins, Philadelphia, 2006.
3. The Cell: A Molecular Approach, 5th Edition, Cooper GM and Hausman RE, ASM Press & Sunderland, Washington, DC, Sinauer Associates, MA, 2009.
4. The World of the Cell,7th Edition, Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP, Pearson Benjamin Cummings Publishing, San Francisco, 2009.

BTL3524 Genomics and Proteomics (4-0-4 = 6)

UNIT-I: GENOMICS & SEQUENCING

Introduction to Genomics, DNA sequencing methods - manual & automated: Maxam & Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.

UNIT-II: GENOME DATA

Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases.

UNIT-III: PROTEIN STRUCTURE & FUNCTION

Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions. Determination of sizes (Sedimentation analysis, gel filteration, SDS-PAGE); Native PAGE, Determination of covalent structures – Edman degradation.

UNIT-IV: PROTEOMICS

Introduction to Proteomics, Analysis of proteomes. 2D-PAGE. Sample preparation, solubilization, reduction, resolution.

Reproducibility of 2D-PAGE. Mass spectrometry based methods for protein identification. *De novo* sequencing using mass spectrometric data.

Practicals:

1. Use of SNP databases at NCBI and other sites
2. Use of OMIM database
3. Detection of Open Reading Frames using ORF Finder
4. Proteomics 2D PAGE database
5. Softwares for Protein localization.
6. Hydropathy plots
7. Native PAGE
8. SDS-PAGE

Recommended Books:

1. Genes IX, Benjamin Lewin, Johns and Bartlett Publisher, 2006.
2. Molecular Cloning: A Laboratory Manual, 3rd Edition, Sambrook and Russell Vol. I to III, 1989.
3. Principles of Gene Manipulation, 6th Edition, Primrose SB, Twyman RM and Old RW, Blackwell Science, 2001.
4. Principles of Genetics, 5th Edition, Snustad DP and Simmons MJ, John Wiley and Sons Inc., 2009.
5. Concepts of Genetics, 9th Edition, Klug WS, Cummings MR and Spencer CA, Benjamin Cummings, 2009.
6. *i*Genetics - A Molecular Approach, 3rd Edition, Russell P J, Benjamin Cummings, 2009.
7. Molecular Biotechnology - Principles and Applications of recombinant DNA, Glick BR and Pasternak JJ, ASM Press, Washington, 2003.
8. Bioinformatics and Functional Genomics, 2nd Edition, Pevsner J, John Wiley & Sons, 2009.

DISCIPLINE SPECIFIC ELECTIVES

BTE3609 Bioinformatics (3-0-4 = 5)

UNIT-I: INTRODUCTION
History of Bioinformatics, The notion of Homology, Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web.

UNIT-II: PROTEIN STRUCTURE
Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Introduction of Data Generating Techniques and Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry.

UNIT-III: BIOINFORMATIC TOOLS
Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments, Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis.

UNIT-IV: DATA BASES
Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission. Genome Annotation: Pattern and repeat finding, Gene identification tools.

Practicals:
1. Sequence information resource
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR)
3. Understanding and using: PDB, Swissprot, TREMBL
4. Using various BLAST and interpretation of results.
5. Retrieval of information from nucleotide databases.
6. Sequence alignment using BLAST.
7. Multiple sequence alignment using Clustal W.

Recommended Books:

1. Bioinformatics: Principles and Applications, Ghosh Z and Bibekanand M, Oxford University Press, 2008.
2. Bioinformatics and Functional Genomics, 2nd Edition, Pevsner J, Wiley-Blackwell, 2009.
3. Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition, Campbell AM and Heyer LJ, Benjamin Cummings, 2006.

BTE3526 Animal Biotechnology (3-0-4 = 5)

UNIT-I: GENE TRANSFER

Gene transfer methods in Animals - Microinjection, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer.

UNIT-II: TRANSGENIC ANIMALS

Introduction to transgenesis. Transgenic Animals - Mice, Cow, Pig, Sheep, Goat, Bird, Insect. Animal diseases need help of Biotechnology - Foot-and mouth disease, Coccidiosis, Trypanosomiasis, Theileriosis.

UNIT-III: ANIMAL PROPAGATION & CONSERVATION

Animal propagation - Artificial insemination, Animal Clones.

Conservation Biology - Embryo transfer techniques. Introduction to Stem Cell Technology and its applications.

UNIT-IV: GENE TRERAPY

Genetic modification in Medicine - gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics.

Practicals:

1. Sterilization techniques: Theory and Practical: Glassware sterilization, Media sterilization, Laboratory sterilization
2. Sources of contamination and decontamination measures.
3. Preparation of Hanks Balanced salt solution
4. Preparation of Minimal Essential Growth medium
5. Isolation of lymphocytes for culturing
6. DNA isolation from animal tissue
7. Quantification of isolated DNA.
8. Resolving DNA on Agarose Gel.

Recommended Books:

1. Molecular Biology Labfax II: Gene Analysis, 2nd Edition, Brown TA, Academic Press, California, USA, 1998.
2. Animal Cell Culture and Technology: The basics, 2nd Edition, Butler M, Bios Scientific Publishers, 2004.
3. Molecular Biotechnology - Principles and Applications of Recombinant DNA, 4th Edition, Glick BR and Pasternak JJ, ASM Press, Washington, USA, 2009.
4. An Introduction to Genetic Analysis, 9th Edition, Griffiths AJF, Miller JH, Suzuki DT, Lewontin RC and Gelbart WM, Freeman & Co., NY, USA, 2009.
5. Recombinant DNA - Genes and Genomes - A Short Course, 3rd Edition, Watson JD, Myers RM, Caudy A and Witkowski JK, Freeman and Co., NY, USA, 2007.

BTE3306 Medical Microbiology (3-0-4 = 5)

UNIT-I: MICROFLORA OF HUMAN BODY & HOST PATHOGEN INTERACTION

Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS

UNIT-II: SAMPLE COLLECTION, TRANSPORT & DIAGNOSIS

Collection, transport and culturing of clinical samples, principles of different diagnostic tests (ELISA, Immunofluorescence, Agglutination based tests, Complement fixation, PCR, DNA probes).

UNIT-III: BACTERIAL & PROTOZOAN DISEASES

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control Respiratory Diseases: *Streptococcus pyogenes, Haemophilus influenzae, Mycobacterium tuberculosis.* Gastrointestinal Diseases: *Escherichia coli, Salmonella typhi, Vibrio cholerae, Helicobacter pylori Others: Staphylococcus aureus, Bacillus anthracis, Clostridium tetani, Treponema pallidum, Clostridium difficie*.

UNIT-IV: VIRAL DISEASES

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control Polio, Herpes, Hepatitis, Rabies, Dengue, AIDS, Influenza with brief description of swine flu, Ebola, Chikungunya, Japanese Encephalitis.

UNIT-V: FUNGAL DISEASES

Brief description of each of the following types of mycoses and one representative disease to be studied with respect to transmission, symptoms and prevention Cutaneous mycoses: Tinea pedis (Athlete's foot), Systemic mycoses: Histoplasmosis Opportunistic mycoses: Candidiasis

Practicals:

1. Identify bacteria (any three of *E. coli, Salmonella, Pseudomonas, Staphylococcus, Bacillus*) using laboratory strains on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests
2. Study of composition and use of important differential media for identification of bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS
3. Study of bacterial flora of skin by swab method
4. Perform antibacterial sensitivity by Kirby-Bauer method
5. Determination of minimal inhibitory concentration (MIC) of an antibiotic.
6. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken pox, HPV warts, AIDS (candidiasis), dermatomycoses (ring worms)
7. Study of various stages of malarial parasite in RBCs using permanent mounts.

Recommended Books:

1. Textbook of Microbiology, 8th Edition, Ananthanarayan R and Paniker CKJ, University Press Publication, 2009.
2. Jawetz, Melnick and Adelberg's Medical Microbiology, 26th Edition, Brooks GF, Carroll KC, Butel JS, Morse SA and Mietzner TA, McGraw Hill Publication, 2013.
3. Brock Biology of Microorganisms, 14th Edition, Madigan MT, Martinko JM, Dunlap PV and Clark DP, Pearson International Edition, 2014.

BTE3108 Animal Diversity I (3-0-4 = 5)

UNIT-I: CLASSIFICATION & TYPES I

Outline of classification of Non- Chordates upto subclasses. Coelomata, Acoelomata, Symmetries, Deutrostomes, Protostomes; Protozoa: Locomotion, Reproduction, evolution of Sex, General features of *Paramoecium* and *Plasmodium*. Pathogenic protozoans; Porifera: General characters, outline of Classification; skeleton, Canal System.

UNIT-II: CLASSIFICATION & TYPES II

Coelenterata: General Characters, Outline of classifications Polymorphism, Various types of stinging cells; Metagenesis, coral reefs and their formation; Platyhelminthes- General Characters; Outline of classification; Pathogenic flatworms: Parasitic adaptations; Aschelminthes: General features, Outline of classification, Pathogenic roundworms and their vectors in relation to man: Parasite adaptation.

UNIT-III: CLASSIFICATION & TYPES III

Annelida: - General features, Outline of classification, Coelom: Metameric segmentation, General features of Earthworm, Vermicomposting; Arthropoda: General Features, Outline of Classification; Larval forms of crustacean, Respiration in Arthropoda; Metamorphosis in insects; Social insects; Insect vectors of diseases; Apiculture, Sericulture.

UNIT-IV: CLASSIFICATION & TYPES IV

Mollusca : General features, Outline of classification, Shell Diversity; Torsion in gastropoda; Echinodermata: General features, Outline of Classification Larval forms; Hemichordata: Phylogeny: Affinities of *Balanoglossus*

Practicals:

1. Identification and Classification of Any these of the following -
   Porifera*: Scypha, Leucosolenia, Euspongia, Hylonema, Euplectella Cnidaria: Medrepora, Millepora, Physalia, Porpita, Valella, Aurelia, Metridium*
   Platyhelminthes: *Taenia, Fasciola,* Aschelminthes*: Ascaris, Ancylostoma, Enterobius* Annelida: *Pheretima, Hirudinaria, Chaetopterus, Nereis, Aphrodite* Arthropoda: *Julus, Scolopendra, Peripatus, Carcinus, Limulus, Lepisma, Dragonfly, Musca, Acheta* Mollusca: *Pila, Unio, Mytilus, Loligo, Sepia, Octopus, Solen*
   Echinodermata: *Asterias, Ophiothrix, Echinus, Holothuria, Astrophyton*
   Hemichordata: *Balanoglossus*
2. Identification of slides with two points of identification.
   Amoeba, Paramoecium, Ceratium, Plasmodium, Opalina, L.S. Sponge, Spicules of sponges, L.S. *Hydra, Obelia, Bougainvillia*, Larvae of *Fasciola,* Seta of Earthworm, Radula
3. Ecological Note - On any of the specimens in Exercise No 1 Models of dissection of Earthworm, Cockroach

Earthworm: Digestive, Nervous System,
Cockroach: Digestive Reproductive, Nervous System

Recommended Books:

1. The Invertebrates: A New Synthesis, 3rd Edition, Barnes RSK, Calow P, Olive PJW, Golding DW and Spicer JI, Blackwell Science, 2002.
2. Comparative Anatomy of the Vertebrates, 9th Edition, Kent GC and Carr RK, The McGraw-Hill Companies, 2000.
3. Invertebrates: A Manual for the use of Students, Boradale LA and Potts EA Asia Publishing Home, 1961.
4. Animals without Backbones, Bushbaum R, University of Chicago Press, 1964.

BTE3110 Plant Diversity I (3-0-4 = 5)

UNIT-I: ALGAE

General character, classification and economic importance. Life histories of algae belonging to various classes: Chlorophyceae - *Volvox, Oedogonium* Xantho phyceae - *Vaucheria* Phaeophyceae - *Ectocarpus* Rhodophyceae - *Polysiphonia.*

UNIT-II: FUNGI

General characters, classification & economic importance. Life histories of Fungi: Mastigomycontina - *Phytophthora,* Zygomycotina - *Mucor* Ascomycotina - *Saccharomyces* Basidomycotina - *Agaricus* Deutromycotina - *Colletotrichum.*

UNIT-III: LICHENS

Classification, general structure, reproduction and economic importance. Plant diseases: 4 of 36; Casual organism, symptoms and control of following plant diseases. Rust & Smut of Wheat; White rust of Crucifers; Late blight of Potato; Red rot of Sugarcane; Citrus Canker.

UNIT-IV: BRYOPHYTES

General characters, classification & economic importance.
Life histories of following: *Marchantia, Funaria.*

Practicals:

1. Comparative study of thallus and reproductive organs of various algae mentioned in theory
2. Comparative study of vegetative and reproductive parts of various fungi mentioned in theory.
3. Study and section cutting and lectophenol mount of plant disease materials studied in theory.
4. Study of various types of lichens.
5. Study of external features & anatomy of vegetative and reproductive parts of Marchantia and Funaria
6. Collection of algae, fungi, plant diseases materials and bryophytes available locally.

Recommended Books:

1. Introductory Phycology, Kumar HD, Aff. East-West Press Pvt Ltd., Delhi, 1999.
2. Phycology, 4th Edition, Lee RE, Cambridge University Press, USA, 2008.
3. A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany, Sambamurty, IK International Publishers, 2008.
4. Bryophyte Biology, Shaw AJ and Goffinet B, Cambridge University Press, 2000.
5. Algae: An introduction to Phycology, Van den Hoek C, Mann DJ and Jahns HM, Cambridge University Press, 1995.
6. Introduction to Bryophytes, Vander-Poorteri, COP, 2009.
7. Economic Botany: Principles and Practices, Wickens GE, Springer Kuwer Publishers, Dordrecht, The Netherlands, 2004.

BTE3109 Animal Diversity II (3-0-4 = 5)

UNIT-I: PROTO-CHORDATES, PISCES & AMBHIBIA

Proto-chordates: Outline of classification, General features*Herdmania, Branchiostoma*Origin of Chordates

Pisces: Migration in Pisces, Outline of classification Amphibia: Classification, Origin, Parental care, Paedogenesis and important characters

UNIT II: REPTILIA, AVES & MAMMALIA

Reptelia: Classification, Origin

Aves: Classification, Origin, flight- adaptations, migration Mammalia: Classification, Origin, dentition

UNIT III: COMPARATIVE ANATOMY OF VERTEBRATES I

Comparative anatomy of various systems of vertebrates: Integumentary, digestive respiratory systems.

UNIT IV: COMPARATIVE ANATOMY OF VERTEBRATES II

Comparative Anatomy of vertebrates – Heart, Aortic arches, Kidney & urinogenital system, Brain, Eye, Ear; Autonomic Nervous system in Mammals

Practicals:

1. Identification & Classification upto order of the following: Proto-chordata: *Salpa, Doliolum, Herdmania, Branchiostom;* Cyclostomata*: Myxine, Petromyzon;* Chondrichthyes: *Scoliodon, Zygnea, Pristis, Trygon, Raja, Chimaera;* Ostiechthyes: *Labeo, Mystus, Catla, Hippocampus, Anabas, Echeneis, Lophius, Polypeterus;* Amphibia: *Rana, Hyla, Amblystoma, Necturus, Proteus.*
   Reptiles: *Hemidactylus, Calotes, Draco, Phrynosoma, Naja Vipera, Bungarus*
   Aves*: Columba, Alcedo, Passer*
   Mammalia: *Ornithorhynchus, Macropus, Didelphes, Dasypus*
2. An Ecological Note on any one of the specimens in Experiment 1
3. Identification of the following slides
   Mammalian Histology: Liver, Lung, Intestine, Kidney, Ovary, Testes Slides of *Salpa, Doliolum,* Spicules of *Herdmania,* Tadpole of Frog
4. Preparation of a permanent mount of *Salpa,* Placoid scales, spicules of *Herdmania,* Pharynax of *Amphioxus,* Tadpole Larva of frog
5. Identification of endoskeletons of frog and rabbit.

Recommended Books:

1. Strickberger's Evolution, 4th Edition, Hall BK and Hallgrimsson B, Jones and Bartlett Publishers Inc., 2008.
2. Vertebrates Comparative Anatomy, Function and evolution, 4th Edition, Kardong KV, McGraw-Hill Higher Education, 2005.
3. Comparative Anatomy of the Vertebrates, 9th Edition, Kent GC and Carr RK, The McGraw-Hill Companies, 2000.
4. Anatomy of Chordate, Weichert CK, McGraw Hill, 1970.
5. The life of vertebrates, 3rd Edition, Young JZ, Oxford university Press, 2004.

BTE3111 Plant Diversity II (3-0-4 = 5)

UNIT-I: PTERIDOPHYTES
General characters of pteridophytes, affinities with bryophytes & gymnosperms, classification, economic importance, study of life histories of fossil Pteridophytes – *Rhynia.*

UNIT II: PTERIDOPHYTES: TYPE STUDIES
Life histories of *Selaginella*- (Heterospory and seed habit), *Equisetum, Pteris, Lycopodium.*

UNIT-III: GYMNOSPERMS
General characters, classification, geological time scale, theories of fossil formation, types of fossils, fossil gymnosperms- *Williamsonia* & *Glossopteris*, telome and stele concept.

UNIT-IV: GYMNOSPERMS:TYPE STUDIES
Life histories of *Cycas & Pinus*, economic importance of gymnosperms.

Practicals:
1. Examination of morphology and anatomy of vegetative and reproductive parts of *Selaginella, Equisetum & Pteris*.
2. Examination of morphology and anatomy of vegetative & reproductive parts of - *Cycas & Pinus*
3. Plant collection (Pteridophytes & Gymnosperms)

Recommended Books:

1. Gymnosperms, Bhatnager SP and Moitra A, New Age International (P) Ltd. Publishers, New Delhi, 1996.
2. The Biology and Morphology of Pteridophytes, Parihar NS, Central Book Depot, Allahabad, 1996.
3. A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany, Sambamurty, IK International Publishers, 2008.
4. Economic Botany: Principles and Practices, Wickens GE, Springer. Kuwer Publishers, Dordrecht, The Netherlands, 2004.

BTE3527 Plant Biotechnology (3-0-4 = 5)

UNIT-I: INTRODUCTION TO CULTURE TYPES

Introduction, Cryo and organogenic differentiation, Types of culture: Seed , Embryo, Callus, Organs, Cell and Protoplast culture. Micropopagation Axillary bud proliferation, Meristem and shoot tip culture, cud culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation.

UNIT-II: HAPLOID CULTURES & PLOIDY

In vitro haploid production Androgenic methods: Anther culture, Microspore culture andogenesis Sgnificance and use of haploids, Ploidy level and chromosome doubling, diplodization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals.

UNIT-III: PROTOPLASTS & SOMATIC HYBRIDIZATION

Protoplast Isolation and fusion Methods of protoplast isolation, Protoplast development, Somatic hybridization, identifiation and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations; Somaclonal variation; Nomenclautre, methods, applications basis and disadvantages.

UNIT-IV: PLANT-MICROBE INTERACTIONS

Plant Growth Promoting bacteria; Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation; Biocontrol of pathogens, Growth promotion by free-living bacteria.

Practicals:

1. Preparation of simple growth nutrient (knop's medium), full strength, half strength, solid and liquid.
2. Preparation of complex nutrient medium (Murashige & Skoog's medium)
3. To selection, Prune, sterilize and prepare an explant for culture.
4. Significance of growth hormones in culture medium.
5. To demonstrate various steps of Micropropagation.

Recommended Books:

1. Plant Tissue Culture and Practice, Bhojwani SS and Razdan, 2004.
2. Principles of Genetics, 8th Edition, Gardner EJ, Simmonns MJ and Snustad DP, Wiley India, 2008.
3. Biolog, Raven PH, Johnson GB, Losos JB and Singer SR,Tata MC Graw Hill, 2005.
4. Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture, Reinert J and Bajaj YPS, Narosa Publishing House, 1997.
5. Plant Biotechnology: The Genetic Manipulation of Plants, Slater A, Scott NW and Fowler MR, Oxford University Press, 2008.

BTE3803 Environmental Biotechnology (3-0-4 = 5)

UNIT-I: FUELS
Conventional fuels and their environmental impact - Firewood, Plant, Animal, Water, Coal and Gas. Modern fuels and their environmental impact - Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol.

UNIT-II: BIOREMEDIATION
Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes. Phyto-remediation. Degradation of pesticides and other toxic chemicals by micro-organisms- degradation aromatic and chlorinates hydrocarbons and petroleum products.

UNIT-III: WASTE TREATMENT
Treatment of municipal waste and Industrial effluents. Bio-fertilizers; Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers (VAM).

UNIT-IV: BIOLEACHING
Bioleaching, Enrichment of oresby microorganisms (Gold, Copper and Uranium); environmental significance of genetically modified microbes, plants and animals.

Practicals:
1. Calculation of Total Dissolved Solids (TDS) of water sample.
2. Calculation of BOD of water sample.
3. Calculation of COD of water sample.
4. Bacterial Examination of Water by MPN Method.

Recommended Books:

1. Environmental Science, Santra SC.
2. Environmental Biotechnology, Pradipta Kumar Mohapatra.
3. Environmental Biotechnology - Concepts and Applications, Hans-Joachim Jordening and Jesef Winter.
4. Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill
5. Agricultural Biotechnology, Purohit SS.
6. Environmental Microbiology: Methods and Protocols, Alicia L Ragout De Spencer, John FT Spencer.
7. Introduction to Environmental Biotechnology, Milton Wainwright.
8. Principles of Environmental Engineering, Gilbert Masters.
9. Wastewater Engineering – Metcalf and Eddy.

BTE3112 IPR, Entrepreneurship, Bioethics & Biosafety (3-0-4 = 5)

UNIT-I: TYPES OF IPR

Introduction to Indian Patent Law. World Trade Organization and its related intellectual property provisions. Intellectual/Industrial property and its legal protection in research, design and development. Patenting in Biotechnology, economic, ethical and depository considerations.

UNIT-II: ENTREPRENEURSHIP

Selection of a product, line, design and development processes, economics on material and energy requirement, stock the product and release the same for making etc. The basic regulations of excise: Demand for a given product, feasibility of its production under given constraints of raw material, energy input, financial situations export potential etc.

UNIT-III: BIOETHICS

Necessity of Bioethics, different paradigms of Bioethics - National & International. Ethical issues against the molecular technologies.

UNIT-IV: BIOSAFETY

Introduction to biosafety and health hazards concerning biotechnology. Introduction to the concept of containment level and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).

Practicals:

1. Proxy filing of Indian Product patent
2. Proxy filing of Indian Process patent
3. Planning of establishing a hypothetical biotechnology industry in India
4. A case study on clinical trials of drugs in India with emphasis on ethical issues.
5. Case study on women health ethics.
6. Case study on medical errors and negligence.
7. Case study on handling and disposal of radioactive waste

Recommended Books:

1. Entrepreneurship: New Venture Creation, David H. Holt
2. Patterns of Entrepreneurship, Jack M. Kaplan
3. Entrepreneurship and Small Business Management, Gupta CB and Khanka SS, Sultan Chand & Sons.
4. Bioethics and Biosafety, Sateesh MK, IK International Pvt Ltd., 2010.
5. Bioethics and Biosafety in Biotechnology, Sree Krishna V, New Age International Publishers, 2007.

BTE3307 Microbial Physiology (3-0-4 = 5)

UNIT-I: MICROBIAL NUTRITION

Nutritional classification of microorganisms based on carbon, energy and electron sources, Metabolite Transport, Diffusion: Passive and facilitated, Primary active and secondary active transport, Group translocation (phosphotransferase system), symport, antiport and uniport, electrogenic and electro neutral transport, transport of Iron.

UNIT-II:MICROBIAL GROWTH & MEASUREMENT

Microbial Growth. Definition of growth, balanced and unbalanced growth, growth curve, the mathematics of growth-generation time, specific growth rate, batch and continuous culture, synchronous growth, diauxie growth curve. Measurement of microbial growth. Measurement of cell numbers, cell mass and metabolic activity

UNIT-III: EFFECT OF FACTORS ON MICROBIAL GROWTH

Effect of the environment on microbial growth; Temperature - temperature ranges for microbial growth, classification based on temperature ranges and adaptations, pH - classification based on pH ranges and adaptations, solutes and water activity, oxygen concentration, radiation and pressure. Chemolithotrophic metabolism, Physiological groups of aerobic and anaerobic chemolithotrophs. Hydrogenoxidizing bacteria and methanogens.

UNIT-IV: PHOTOTROPHIC METABOLISM

Historical account of photosynthesis, diversity of phototrophic bacteria, anoxygenic and oxygenic photosynthesis, photosynthetic pigments: action and absorption spectrum, type, structure and location, physiology of bacterial photosynthesis: light reactions, cyclic and non-cyclic photophosphorylation. Carbon dioxide fixation, Calvin cycle and reductive TCA cycle.

Practicals:

1. To study and plot the growth curve of *E coli* using turbidometric method and to calculate specific growth rate and generation time.
2. To study and plot the growth curve of *Aspergillus niger* by radial growth measurements.
3. To study the effect of pH on the growth of *E. coli*
4. To study the effect of temperature of *Aspergillus niger* by dry weight method.
5. Demonstration of the thermal death time and decimal reduction time of *E. coli.*

Recommended Books:

1. Bacterial Metabolism, 2nd Edition, Gottschalk G, Springer Verlag, 1986.
2. Brock Biology of Microorganisms, 10th Edition, Madigan MT, Martinko JM and Parker J, Pearson/ Benjamin Cummings, 2003.
3. Microbial Physiology, 4th Edition, Moat AG and Foster JW, John Wiley & Sons, 2002.
4. Microbial Physiology, Reddy SR and Reddy SM, Scientific Publishers India, 2005.
5. General Microbiology, 5th Edition, Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. McMillan Press, 1987.
6. Prescott, Harley and Klein's Microbiology, 7th Edition, Willey JM, Sherwood LM, and Woolverton CJ, McGraw Hill Higher Education, 2008.

BTE3610 Introduction to Biostatistics (3-0-4 = 5)

UNIT-I: DATA TYPES

Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis.

UNIT-II: PROBABILITY

Probability classical & axiomatic definition of probability, Theorems on total and compound probability), Elementary ideas of Binomial, Poisson and Normal distributions.

UNIT-III: SAMPLING METHODS

Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Problems on test of significance, t-test, chi-square test for goodness of fit and analysis of variance (ANOVA)

UNIT IV: REGRESSION

Correlation and Regression. Emphasis on examples from Biological Sciences.

Practicals:

1. Based on graphical Representation
2. Based on measures of Central Tendency & Dispersion
3. Based on Distributions Binomial Poisson Normal
4. Based on t, f, z and Chi-square

Recommended Books:

1. Introductory biostatistics, 1st Edition, Le CT, John Wiley, USA, 2003.
2. High Yield™ Biostatistics, Glaser AN, Lippincott Williams and Wilkins, USA, 2001.
3. Advanced Biology Statistics, Edmondson A and Druce D, Oxford University Press, 1996.
4. Biostatistics: A foundation for Analysis in Health Sciences, Danial W, John Wiley and Sons Inc., 2004.

BTE3804 Ecology and Environment Management (3-0-4 = 5)

UNIT-I: OUR ENVIRONMENT

Geological consideration of Atmosphere, Hydrosphere, Lithosphere Scope of Ecology. Development & Evolution of Ecosystem. Principles & Concepts of Ecosystem. Structure of ecosystem. Strata of an ecosystem. Types of ecosystem including habitats. Cybernetics & Homeostasis. Biological control of chemical environment.

UNIT-II: ENERGY TRANSFER IN AN ECOSYSTEM

Food chain, food web, Energy budget, Production & decomposition in a system. Ecological efficiencies, Trophic structure & energy pyramids, Ecological energetic, principles pertaining to limiting factors, Bio-geochemical cycles (N, C, P cycles).

UNIT-III: POLLUTION & ENVIRONMENT

Pollution & environmental Health related to Soil, Water, Air, Food, Pesticides, Metals, Solvents, Radiations ,Carcinogen, Poisons. Detection of Environmental pollutant. Indicators & detection systems. Bio-transformation, Plastic, Aromatics, Hazardous wastes Environmental cleanup: Case studies.

UNIT-IV: ENVIRONMENTAL BIOTECHNOLOGIES

Biotechnologies in protection and preservation of environment; Bioremediation, Waste disposal.

Practicals:

1. Study of all the biotic and abiotic components of any simple ecosystem- natural pond or terrestrial ecosystem or human modified ecosystem.
2. Determination of population density in a terrestrial community or hypothetical community by quad rate method and calculation of the Simpson's and Shannon-Weiner diversity index for the same community.
3. Principle of GPS (Global Positioning System).
4. Study of the life table and fecundity table, plotting of the three types of survivorship curves from the hypothetical data.
5. Study of the types of soil, their texture by sieve method and rapid tests for -pH, chlorides, nitrates, carbonates and organic carbon
6. Study any five endangered/ threatened species- one from each class.

Recommended Books:

1. Ecology: Principles and Applications, 2nd Edition, Chapman JL and Reiss MJ, Cambridge University Press, 1999.
2. Social Forestry and Forest Management, Ghosh SK and Singh R, Global Vision Publishing House, 2003.
3. Basics of Environmental Science, Michael Allabay, Routledge Press.
4. Sustaining the Earth, an Integrated Approach, 5th Edition, Miller GT, Books/Cole, Thompson Learning, Inc., 2002.
5. Environmental Pollution - Health and Toxicology, Rana SVS, Narosa Publication.
6. Handbook on Wildlife Law Enforcement in India, Sinha S, TRAFFIC, India, 2010.

SKILL ENHANCEMENT COURSES

BTE2519 Molecular Diagnostics (4-0-0 = 4)

UNIT-I: ENZYME IMMUNOASSAYS

Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes. Solid phases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays. Enzyme immunoassays after immuno blotting. Enzyme immuno histochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immuno assays; Applications of enzyme immunoassays in diagnostic microbiology.

UNIT-II: MOLECULAR METHODS IN CLINICAL MICROBIOLOGY:

Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology; Laboratory tests in chemotherapy:
Susceptibility tests: Micro-dilution and macro-dilution broth procedures. Susceptibility tests:Diffusion test procedures. Susceptibility tests: Tests for bactericidal activity. Automated procedures for antimicrobial susceptibility tests.

UNIT-III: AUTOMATION IN MICROBIAL DIAGNOSIS

Rapid diagnostic approach including technical purification and standardization of antigen and specific antibodies. Concepts and methods in idiotypes. Antiidiotypes and molecular mimicry and receptors. Epitope design and applications. Immunodiagnostic tests. Immuno florescence. Radioimmunoassay.

UNIT-IV: DIAGNOSTIC TECHNIQUES

GLC, HPLC, Electron microscopy, flowcytometry and cell sorting. Transgenic animals.

Practicals:

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Perform/demonstrate RFLP and its analysis
2. Kirby-Bauyer method (disc-diffusion method) to study antibiotic sensitivity of a bacterial culture
3. A kit-basd detection of a microbial infection (Widal test)
4. Study of Electron micrographs (any four).
5. Perform any one immuno diagnostic test (Typhoid, Malaria, Dengue)

Recommended Books:

1. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker.
2. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, Van Impe JF, Kluwer Academic
3. Textbook of Microbiology, 7th Edition, Ananthanarayan R and Paniker CKJ (Eds Paniker CKJ), University Press Publication, 2005.
4. Jawetz, Melnick and Adelberg's Medical Microbiology, 24th Edition, Brooks GF, Carroll KC, Butel JS and Morse SA, McGraw Hill Publication, 2007.
5. Mims' Medical Microbiology, 4th Edition, Goering R, Dockrell H, Zuckerman M and Wakelin D, Elsevier, 2007.
6. Prescott, Harley and Klein's Microbiology, 7th Edition, Willey JM, Sherwood LM, and Woolverton CJ, McGraw Hill Higher Education, 2008.

BTE2520 Industrial Fermentations (4-0-0 = 4)

UNIT-I: FERMENTATION APPLICATIONS

Production of industrial chemicals, biochemicals and chemotherapeutic products. Propionic acid, butyric acid, 2-3 butanediol, gluconic acid, itaconic acid, Biofuels: Biogas, Ethanol, butanol, hydrogen, biodiesel, microbial electricity, starch conversion processes; Microbial polysaccharides; Microbial insecticides; microbial flavours and fragrances, newer antibiotics, anti cancer agents, amino acids.

UNIT-II: FERMENTATION & ENZYMES

Microbial products of pharmacological interest, steriod fermentations and transformations. Over production of microbial metabolite, Secondary metabolism – its significance and products; Metabolic engineering of secondary metabolism for highest productivity; Enzyme and cell immobilization techniques in industrial processing, enzymes in organic synthesis, proteolytic enzymes, hydrolytic enzymes, glucose isomerase, enzymes in food technology/organic synthesis.

UNIT-III: DOWNSTREAM PROCESSING

Purification & characterization of proteins, Upstream and downstream processing, solids and liquid handling. Distribution of microbial cells, centrifugation, filtration of fermentation broth, ultra centrifugation, liquid extraction, ion-exchange recovery of biological products; Experimental model for design of fermentation systems, Anaerobic fermentations.

UNIT-IV: ENZYME KINETICS

Rate equations for enzyme kinetics, simple and complex reactions. Inhibition kinetics; effect of pH and temperature on rate of enzyme reactions. Mathematical derivation of growth kinetics, mathematical derivations of batch and continuous culture operations; single stage CSTR; mass transfer in aerobic fermentation; resistances encountered; overall mass transfer co-efficient (Ka) determination, factors depending on scale up principle and different methods of scaling up. Metabolic engineering of antibiotic biosynthetic pathways.

Practicals:

1. Comparative analysis of design of a batch and continuous fermenter.
2. Calculation of Mathematical derivation of growth kinetics.
3. Solvent extraction & analysis of a metabolite from a bacterial culture.
4. Perform an enzyme assay demonstrating its hydrolytic activity (protease/peptidase/glucosidase etc.)

Recommended Books:

1. Industrial Microbiology, 1st Edition, Casida LE, Wiley Eastern Limited, 1991.
2. Biotechnology: A textbook of Industrial Microbiology, 2nd Edition, Crueger W and Crueger A, Panima Publishing Co. New Delhi, 2000.
3. Industrial Microbiology, 1st Edition, Patel AH, Macmillan India Limited, 1996.
4. Principles of Fermentation Technology, 2nd Edition, Stanbury PF, Whitaker A and Hall SJ, Elsevier Science Ltd., 2006.

BTE2211 **Enzymology** **(4-0-0 = 4)**

UNIT-I: INTRODUCTION TO ENZYMES

Isolation, crystallization and purification of enzymes, test of homogeneity of enzyme preparation, methods of enzyme analysis; Enzyme classification (rationale, overview and specific examples) Zymogens and their activation (Proteases and Prothrombin); Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Kinetics of enzyme activity, Michaelis-Menten equation and its derivation; Different plots for the determination of Km and Vmax and their physiological significance, factors affecting initial rate, E, S, temp. & pH. Collision and transition state theories, Significance of activation energy and free energy.

UNIT-II: REACTION RATES

Two substrate reactions (Random, ordered and ping-pong mechanism) Enzyme inhibition types of inhibition, determination of Ki, suicide inhibitor; Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency: proximity, orientation, distortion of strain, acid-base, nucleophilic and covalent catalysis. Techniques for studying mechanisms of action, chemical modification of active site groups, specific examples-: chymotrypsin, Iysozyme, GPDH, aldolase, RNase, Carboxypeptidase and alcohol dehydrogenase; Enzyme regulation: Product inhibition, feed backcontrol, covalent modification.

UNIT-III: ALLOSTERIC ENZYMES

Allosteric enzymes with special reference to aspartate transcarbomylase and phosphofructokinase. Qualitative description of concerted and sequential models. Negative co-operativity and half site reactivity. Enzyme - Enzyme interaction, Protein ligand binding, measurements analysis of binding isotherm, cooperativity, Hill and scatchard plots, kinetics of allosteric enzymes. Isoenzymes - multiple forms of enzymes with special reference to lactate dehydrogenase. Multienzyme complexes. Ribozymes. Multifunctional enzyme-eg Fatty Acid synthase.

UNIT-IV: ENZYME TECHNOLOGY

Methods for large scale production of enzymes; Immobilized enzyme and their comparison with soluble enzymes, Methods for immobilization of enzymes. Immobilized enzyme reactors. Application of Immobilized and soluble enzyme in health and industry. Application to fundamental studies of biochemistry. Enzyme electrodes; Thermal stability and catalytic efficiency of enzyme, site directed mutagenesis and enzyme engineering - selected examples, Delivery system for protein pharmaceuticals, structure function relationship in enzymes, structural motifs and enzyme evolution.
Methods for protein sequencing. Methods for analysis of secondary and tertiary structures of enzymes. Protein folding *in vitro* & i*n vivo*.

Practicals:

1. Purification of an enzyme from any natural resource
2. Quantitative estimation of proteins by Bradford/Lowry's method.
3. Perform assay for the purified enzyme.
4. Calculation of kinetic parameters such as Km, Vmax, Kcat

Recommended Books:

1. Biochemistry, 6th Edition, Lubert Stryer, WH Freeman, 2006.
2. Harper's illustrated Biochemistry, 28th Edition, Robert K Murray, David A Bender, Kathleen M Botham, Peter J Kennelly, Victor W Rodwell, P Anthony Weil, Mc Graw Hill, 2009.
3. Biochemistry, 5th Edition, Mary K Campbell and Shawn O Farrell, Cenage Learning, 2005.
4. Fundamentals of Enzyme Kinetics, Athel Cornish, Bowden Portland Press, 2004

BTE2522 Basics of Forensic Science (4-0-0 = 4)

UNIT-I: INTRODUCTION AND PRINCIPLES

Forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science, causes of crime, role of modus operandi in criminal investigation. Classification of injuries and their medico-legal aspects, method of assessing various types of deaths.

UNIT-II: FIRE ARMS AND EXPLOSIVES

Classification of fire arms and explosives, introduction to internal, external and terminal ballistics. Chemical evidence for explosives. General and individual characteristics of handwriting, examination and comparison of handwritings and analysis of ink various samples.

Unit-III: TOXICOLOGICAL FINDINGS

Role of the toxicologist, significance of toxicological findings, Fundamental principles of fingerprinting, classification of fingerprints, development of finger print as science for personal identification,

Unit-IV: TECHNIQUES OF FORENSIC SCIENCE

Principle of DNA fingerprinting, application of DNA profiling in forensic medicine, Investigation Tools, eDiscovery, Evidence Preservation, Search and Seizure of Computers, Introduction to Cyber security.

Practicals:

1. Documentation of crime scene by photography, sketching and field notes.
2. a. Simulation of a crime scene for training.
   b. To lift footprints from crime scene.
3. Case studies to depict different types of injuries and death.
4. Separation of nitro compounds (explosives)/ ink samples by thin layer chromatography.
5. Investigate method for developing fingerprints by Iodine crystals.
6. PCR amplification on target DNA and DNA profiling,
7. E-Mail Investigation, E-Mail Tracking, IP Tracking, E-Mail Recovery, Recovering deleted evidences, Password Cracking.

Recommended Books:

1. Molecular Biotechnology- Principles and Applications of recombinant DNA, ASM Press, Washington.
2. Forensic Science in India: A Vision for the Twenty First Century, Nanda BB and Tiwari RK, Select Publishers, New Delhi, 2001.
3. Role of Forensic Science in the New Millennium, Bhasin MK and Nath S, University of Delhi, Delhi, 2002.
4. Forensic Science: An Introduction to Scientific and Investigative Techniques, 2nd Edition, James SH and Nordby JJ, CRC Press, Boca Raton, 2005.
5. Wright in Introduction to Forensic Sciences, 2nd Edition, Eckert WG, CRC Press, Boca Raton 1997.
6. Criminalistics, 8th Edition, Saferstein R, Prentice Hall, New Jersey, 2004.
7. Fisher's Techniques of Crime Scene Investigation, Tilstone WJ, Hastrup ML and Hald C, CRC Press, Boca Raton, 2013.